Defining Body Regions by AIS© for Categorizing Injuries of Powered-Two-Wheelers

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I. INTRODUCTION

Finding countermeasures to reduce injury among Powered-Two-Wheeler (PTW) riders is of increasing interest to the global community. The first step in identifying and developing appropriate countermeasures to reduce injury is to understand the types and mechanisms of injury sustained by riders.

In the EC funded PIONEERS project (Protective Innovations of New Equipment for Enhanced Rider Safety) [1] we are examining accident scenarios, use cases, riders' injuries, the usage and performance of personal protective equipment (PPE) using technical and kinematic information from reconstructed accidents with the ultimate aim of developing enhanced protective technologies and on-board safety systems (OBSS) to reduce PTW casualties. The first phase of this project involved using data from European and Australian national and in-depth databases, to understand the nature of injury and mechanisms of injury to PTW riders for the purposes of developing countermeasures to injury across specific body regions [2]. To facilitate this there was a need to develop a common definition for Body Regions. However, there is no global (medical or other) definition of *body region*. Using the first digit of the AIS codes as body regions, categorised by chapters in the AIS code book [3], does not appear sufficient for countermeasure development for PTW riders. The aim of this work was therefore to identify a meaningful concept of body regions for preventing injury among PTW riders.

II. METHODS

A work group was established to develop definitions of body regions for PIONEERS using literature review and expert consensus.

Literature review

Previous European projects and literature on PTW safety were reviewed, and public injury research databases were screened to identify whether they included: definitions of body regions (yes/no), used AIS or other tools for body region definition and how many and which body regions were used.

Work group discussions, expert opinion, compromise

Based on the literature review the work group discussed priorities. As most of the Partners in the project providing accident data on PTW accidents use AIS coding (versions 2005 update 2008, and 2015) it was decided to base the definitions on AIS codes. As the project focuses on PPE and OBSS, the aim was to develop the definition from a *whole body* and injury mechanism perspective. Each body region was discussed with a view on what injuries should be included under which body region and in terms of common mechanisms of injury. It was also acknowledged that the definition would be constrained by what is possible with the available data and with the given structure of the AIS. Finally, it was agreed that comprehensibility of the final definition was of utmost importance and that the definition must be workable for both single case level data as well as aggregated data. Any assignment of injuries to body regions must therefore not lead to a loss of information but simply provide a structure for communication.

III. INITIAL FINDINGS

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Fourteen relevant references were identified, see also [2]: three were databases (CIREN, Eurosafe, IGLAD [4-7]), seven EU-Projects (MAIDS, MOSAFIM, MOTORIST, PISa, SIM, APROSYS, Serious Injuries Study) and four were conference papers (2x Ircobi [8-9], 1x AAAM [10], 1x Australasian Road Safety Research, Policing and Education Conference [11]). Only four references provided a definition of the body regions. Two of these were based on the AIS (presenting nine and 19 different body regions), one used the WHO International Classification of Diseases (ICD) with five body regions, and one was based on the WHO International Classification of External Causes of Injury (ICECI) and on the European Home and Leisure Accident Surveillance System (EHLASS) with 25 body regions in the Minimum Data Set [5]. For ten references, it can be assumed that they used the AIS chapters as definition of their body regions, however, these illustrated the deficiency of simply using the AIS without any specific definition of PTW relevant body regions as within these references there were between seven and nine different and not concordant body regions. How external injuries were treated (coded and distributed to body regions) was never documented. We did not find a reference using the definition given by the Injury Severity Score [3].

Expert discussion centred on mechanism of injury to riders, potential of PPEs and the assignment and grouping of the following body parts, and structures: head, face, neck, cervical, thoracic, and lumbar spine, scapula body, clavicle, pelvic contents, sacral plexus, pelvic bone, hip, thigh, knee, lower leg, ankle, foot, shoulder, elbow, and skin. Taking into account the aims and constraints for the PTW body region definition described above, consensus was reached to limit the number of different body regions to seven, see Table I.

TABLE I

PIONEERS DEFINITIONS FOR BODY REGIONS

BODY REGION NAME	SHORT-CUT	DEFINITION BY AIS © 2005 UPDATE 2008 CODES
Head & face	HF	all codes of Chapter 1 AND Chapter 2 in AIS
Neck & Cervical Spine	NCS	all codes of Chapter 3 in AIS AND cervical spine (part of Chapter 6 in AIS): first digit of Unique numerical identifier (UNI) "6", fourth digit "2", AND the codes "600099.9", "600999.9", and "613000.6"
Thorax & Thoracic Spine	TTS	all codes of Chapter 4 in AIS AND thoracic spine (part of Chapter 6 in AIS): first digit of UNI "6", fourth digit "4", AND the codes "620099.9", and "620999.9"
Abdomen & Lumbar Spine	ALS	all codes of Chapter 5 in AIS except Pelvis (see there) AND lumbar spine (part of Chapter 6 in AIS): first digit of UNI "6", fourth digit "6", AND the codes "630099.9", and "630999.9"
Upper Extremities	UE	all codes of Chapter 7 in AIS
Lower Extremities	LE	all codes of Chapter 8 in AIS except Pelvis (see there)
Pelvis (Bone and pelvic content)	P	AIS codes 811001.4, 811010.5, 813001.4, 816010.1, 816011.1, 816012.2, 816013.3 AND UNI starts with 8561, 8562, 5206, 5208, 5210, 5404, 5406, 5424, 5426, 5430, 5432, 5435, 5436, 5440, 5446, 5450, 5452, 5454, 5456

Legend of AIS codes are found in the AIS © 2005 update 2008 version (AAAM, 2008)

IV. DISCUSSION

For the first time an assignment of injuries coded by AIS © to defined body regions relevant to PTW rider protection is presented. Limitations in the development process include the level of injury detail available to some PIONEERS partners and coding approaches within databases, i.e., for external injuries. Further limitations were inherent to the AIS, i.e., the sacral plexus cannot be assigned to the pelvic region, as it is combined with the lumbar nerves within the spine chapter. However, there are many strengths of the new definition. No overall external region is defined, as for PPE it is essential to know where on the body external injuries occur. The practicality of the new definition will be tested in future analyses and may be improved, or adjusted as needed.

V. ACKNOWLEDGEMENTS

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